



Focus: Water Quality in Battle Ground Lake

Introduction

Battle Ground Lake, one of Clark County's valued resources, has been under close scrutiny lately. Referred to by some as a "Little Crater Lake", 26-acre Battle Ground Lake is surrounded by state forest near the town of Battle Ground, Washington. Of volcanic origin, the lake is believed to have formed as a result of hot lava pushing up near the surface of the earth creating a small cone that later became a lake.

The lake is popular for swimming, fishing, and camping. Recently, however, human impacts to the lake have become more noticeable, including overgrowth of Brazilian Elodea, a non-native invasive aquatic plant; an algal bloom in 2003; and the closing of the swimming beach in 1999 because of harmful E.coli bacteria in the lake water. Clark County Public Works, Water Resources staff monitored the lake from May to October, 2003 to assess the overall health of the lake.

This focus sheet summarizes what is known about the lake as detailed in the 2004 [*Battle Ground Lake Assessment Report*](#) produced by the Water Resources section of Clark County Public Works.



Swimming area at Battle Ground Lake State Park

Background

It is impossible to generalize what the water quality of a particular lake *should* be. Lakes are dynamic systems that change naturally over time. However, human activities can increase the *rate* at which a lake changes, and that is what lake scientists attempt to quantify when they study a lake.

To unravel the dynamics of a lake, scientists try to answer two fundamental questions: Does the lake have more nutrients than it naturally would have? and How will an increase in nutrients change the lake? The growth of aquatic plants and their evolutionary precursors, algae, are indicators of nutrient and sun light availability. However, an increase in algae and plant growth indicates that nutrient enrichment may be a problem. To research the condition of a lake, scientists focus on algal quantity and diversity, water clarity, the concentration of nutrients, and the temperature and dissolved oxygen levels at various depths.

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Algal quantity

Algal quantity is a measurement of the density of algae present in a lake. These are the primary producers forming the base of the aquatic food chain. They can also cloud the water by reproducing quickly under favorable conditions. Along with the density, the diversity of algal species gives us a good indication of water quality. Just as a botanist can survey and rank a section of forest by identifying all the plants, scientists can read the flora of a lake. Each alga species has different conditions it can tolerate. By identifying a lake's algae, an estimate can be made of the health of the system.

Water clarity

Water clarity gives scientists a general indication of how much stuff is floating in the water, including suspended sediments, algae, microscopic organisms other than algae, and dissolved materials that color the water. As water clarity is reduced over time, organisms will have to adapt to less sunlight, more competition for nutrients and, depending on where they are in the water column, possibly a shortage of oxygen.

Nutrients

The nutrients nitrogen and phosphorus have been found to be the most important nutrients that limit plant growth, with phosphorus often the most important in freshwater lakes. In other words, algae and aquatic plants grow either slowly or quickly depending on the amount of phosphorus available.

Temperature and dissolved oxygen

All aquatic organisms require dissolved oxygen and temperature to be within a certain range. The two parameters are often measured together because they are linked; cold water holds more dissolved oxygen than warm water. Clark County measured dissolved oxygen and

temperature at one meter (3.3 feet) intervals from the surface to the bottom of Battle Ground Lake throughout the summer of 2003.

Summary of results

The conclusions of the Battle Ground Lake report are qualified by a comparative lack of previous data about the lake's water quality and the need for further study. In addition to addressing the overall condition of the lake, the report addressed the impacts on water quality of an herbicide applied by the state in 2003 to control Brazilian Elodea.

Battle Ground Lake does not have high levels of phosphorus and has a moderate level of algal production. It still provides what most lake users are looking for - clear, cold, deep water for swimming and fishing - but may not live up to the nickname of "Little Crater Lake". Potential bloom-forming algae, known as blue-green algae, were found in the spring of 2003, although at levels that were not considered to be a nuisance. If nutrients remain at their current levels or increase, nuisance algal blooms could become a problem, clouding the water and inhibiting recreational use.

Because the lake has no inflowing or outflowing streams, it is difficult to pinpoint the source of the nutrients. Precipitation, erosion from surrounding hills, and recreational users all contribute, but it is unknown if these are significant contributions. Groundwater could be an important source of water and nutrients. While the lake still provides excellent swimming and fishing, it should be carefully monitored since any pollution that enters the lake will probably be there for a long time. Additional data are needed to determine whether nutrient levels, and thus algal blooms, are increasing or decreasing.



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The herbicide applied in 2003 does not appear to be limiting water quality. The Brazilian Elodea infestation has been knocked back, but isn't completely gone. In 2004, the Washington State Parks Department hired divers to hand-pull the Elodea that had grown back. Like most non-native, invasive plants, Elodea can be controlled but is nearly impossible to eradicate completely. Testing by the Clark County Health Department and Washington State Parks Department since the beach closure in 1999 has revealed no E.coli levels above the state standard and the swimming beach has remained open.

Temperature and dissolved oxygen measurements revealed that the lake was strongly stratified, or separated into layers by temperature, from early May through September, 2003. This is not surprising

because cold water is denser than warm water and will sink as the sun warms the upper layer of a lake. In the top layer of Battle Ground Lake during this period of 2003, algae thrived in the nutrient-rich, warm water. The algae produced oxygen and so the top layer had plenty of oxygen for fish and other aquatic species. However, as the algae died off and fell to the bottom of the lake the decomposition process consumed oxygen. This explains why there was essentially no oxygen below a depth of about 5 meters (16.5 feet) from May through September in Battle Ground Lake. The combination of low oxygen in the deeper part of the lake and warm temperatures at the surface reduces available habitat for cold-water fish species. It is not known if this is a recent phenomenon or a feature of the lake's unique hydrology.

For more information about the water quality of the lake:

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Or, visit the Clean Water Program website:
www.clark.wa.gov/water-resources/index.html

For information about visiting the park:

Battle Ground State Park
(360) 687-4621
<http://www.parks.wa.gov/>



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